CLAIMS

WHAT IS CLAIMED IS:

1. A multi-cell fuel cell layer, comprising:

a substrate;

an array of fuel cells each having an anode, a cathode, and an electrolyte disposed on said substrate;

conductors electrically coupled to said fuel cell array;

a fuel flow channel defined in an anode side of said substrate; and

a cathode air flow channel defined in a cathode side of said substrate.

2. The fuel cell layer of claim 1, further comprising a fuel inlet and an exhaust defined in said substrate.

3. The fuel cell layer of claim 2, wherein said fuel inlet and said exhaust are in fluid communication with said fuel flow channel.

4. The fuel cell layer of claim 2, further comprising a cathode air inlet and an excess cathode air outlet defined in said substrate.

5. The fuel cell layer of claim 4, wherein said cathode air inlet and said excess cathode air outlet are in fluid communication with said cathode air flow channel.

6. The fuel cell layer of claim 4, wherein said fuel inlet and exhausts are defined in first and second opposing corner portions of said substrate and said inlet cathode air and excess cathode air outlets are defined in third and fourth opposing corner portions of said substrate.

7. The fuel cell layer of claim 1, wherein said substrate comprises a substantially rectilinear substrate.

8. The fuel cell layer of claim 4, wherein said conductors comprise a positive conductor coupled to said cathode air inlet and a negative conductor coupled to said excess cathode air outlet.

9. The fuel cell layer of claim 1, wherein said fuel flow channel is defined along a first axis and said cathode air flow channel is disposed along a second axis disposed at an angle with said first axis.

10. The fuel cell layer of claim 9, wherein said first axis is substantially normal to said second axis.

11. The fuel cell layer of claim 1, wherein said conductors are located on said cathode side of said substrate, said cathode side serving as a circuit side of said substrate.

12. The fuel cell layer of claim 1, wherein said electrolyte seals non-active portions of said substrate.

13. The fuel cell layer of claim 1, further comprising flow modification features associated with each of said fuel flow channel and said cathode air flow channel.

14. The fuel cell layer of claim 13, wherein said flow modification features comprise a plurality of baffles.

15. The fuel cell layer of claim 1, wherein said conductors are located on said anode side of said substrate, said anode side serving as a circuit side of said fuel cell layer.

16. A fuel cell system, comprising:

a plurality of fuel cell layers each including an array of fuel cells each having an anode, a cathode, an electrolyte and conductors disposed on a substrate, a fuel flow channel defined in an anode side of said substrate, and a cathode air flow channel defined in a cathode side of said substrate,

wherein said fuel cell stacks are alternatingly stacked.

17. The system of claim 16, wherein said fuel cell layers are coupled such that a fuel cell layer shares a fuel flow channel with a first adjacent fuel cell layer thereby forming fuel flow plenum.

18. The system of claim 17, wherein said fuel cell layers are coupled such that a fuel cell layer shares a cathode air flow channel with a second adjacent fuel cell layer thereby forming a cathode air flow plenum.

19. The system of claim 18, further comprising fuel inlets and exhausts defined in said substrates.

20. The system of claim 19, wherein a plurality of said fuel inlets form a fuel inlet plenum and a plurality of said exhausts form an exhaust plenum.

21. The system of claim 20, wherein said fuel inlet plenum and said exhaust plenum are in fluid communication with said fuel flow plenums.

22. The system of claim 21, further comprising cathode air inlets and excess cathode air outlets defined in said substrates.

23. The system of claim 22, wherein a plurality of said cathode air inlets form a cathode air inlet plenum and a plurality of said excess cathode air outlets form an excess cathode air outlet plenum.

24. The system of claim 23, wherein said inlet cathode air plenum and said excess cathode air outlet plenum are in fluid communication with said cathode air flow plenums.

25. The system of claim 24, wherein said conductors further comprise a positive conductor on each of said fuel cell stacks coupled to said cathode air inlets and a negative conductor on each of said fuel cell stacks coupled to said excess cathode air outlets.

26. The system of claim 25, further comprising a positive stack connection coupled to each of said positive conductors disposed in said inlet cathode air plenum and a negative stack connection coupled to each of said negative conductors disposed in said excess cathode air outlet plenum.

27. The system of claim 26, wherein said fuel inlets and exhausts are defined in first and second opposing corner portions of said substrate and said inlet cathode air and excess cathode air outlets are defined in third and fourth opposing corner portions of said substrate.

28. The system of claim 27, wherein said substrates comprise substantially rectilinear substrates.

29. The system of claim 28, wherein said conductors comprise a positive conductor coupled to said cathode air inlet and a negative conductor coupled to said excess cathode air outlet.

30. The system of claim 16, wherein each of said fuel flow channels is defined along a first axis and each of said cathode air plenums is disposed along a second axis disposed at an angle with said first axis.

31. The system of claim 30, wherein said first axis is substantially normal to said second axis.

32. The system of claim 31, wherein each of said cathode sides comprises a circuit side, wherein said conductors are located on said circuit side.

33. The system of claim 16, wherein said electrolyte seals non-active portions of said substrate.

34. The system of claim 16, further comprising:

a fuel inlet and an exhaust fluidly coupled to each said fuel flow channel;

a cathode air inlet and an excess cathode air outlet fluidly coupled to each said cathode air flow channel; and

seals disposed around said inlets, exhaust and outlet and around a perimeter of said fuel cell array.

35. The system of claim 34, wherein said seals comprise an electrically conductive material.

36. The system of claim 16, wherein said fuel cell layers are coupled so as to form a parallel electrical circuit.

37. The system of claim 25, further comprising a fuel manifold having a plurality of selectively opened inlet ports coupled to said fuel flow plenums disposed within said fuel inlet plenum, and an exhaust manifold having a plurality of selectively opened inlet ports coupled to said fuel flow plenums disposed within said exhaust plenum.

38. The system of claim 37, further comprising a cathode air inlet manifold having a plurality of selectively opened inlet ports coupled to said cathode air flow plenums

disposed within said cathode air inlet plenum, and an excess cathode air manifold having a plurality of selectively opened inlet ports coupled to said cathode air flow plenums disposed within said excess cathode air plenum.

39. A method of forming a fuel cell system, comprising:

providing a plurality of fuel cell layers having a substrate, an array of fuel cells each having anode, a cathode, an electrolyte and conductors disposed on said substrate, a fuel flow channel defined in an anode side of said substrate, and a cathode air flow channel defined in a cathode side of said substrate; and

coupling said fuel cell layers such that a fuel cell layer shares a cathode air flow channel with a first adjacent fuel cell layer and a fuel flow channel with a second adjacent fuel cell layer.

40. The method of claim 39, further comprising forming fuel inlets and exhausts in said substrates.

41. The method of claim 40, wherein said fuel inlets collectively form a fuel inlet plenum and said exhausts collectively form an exhaust plenum.

42. The method of claim 41, wherein said fuel inlet plenum and said exhaust plenum are in fluid communication with said fuel flow channels.

43. The method of claim 42, further comprising forming cathode air inlets and excess cathode air outlets in said substrates.

44. The method of claim 43, wherein said cathode air inlets collectively form a cathode air inlet plenum and said excess cathode air outlets collectively form a cathode air outlet plenum.

45. The method of claim 44, wherein said inlet cathode air plenum and said excess cathode air outlet plenum is in fluid communication with said cathode air flow channels.

46. The method of claim 44, wherein said conductors further comprise a positive conductor on each of said fuel cell layers coupled to said cathode air inlets and a negative conductor on each of said fuel cell layers coupled to said excess cathode air outlets.

47. The method of claim 46, further comprising a coupling a positive stack connection to each of said positive conductors and disposing said positive stack connection in said inlet cathode air plenum and coupling a negative stack connection to each of said negative conductors and disposing said negative stack connection in said excess cathode air outlet plenum.

48. The method of claim 47, wherein said substrate fuel inlets and exhausts are defined in first and second opposing corner portions of said substrate and said cathode air inlets and excess cathode air outlets are defined in third and fourth opposing corner portions of said substrate.

49. The method of claim 48, wherein said substrates comprise substantially rectilinear substrates.

50. The method of claim 49, wherein said conductors comprise coupling a positive conductor to said cathode air inlet and a negative conductor to said excess cathode air outlet.

51. The method of claim 39, further comprising forming each of said fuel flow channels along a first axis and each of said cathode air channels along a second axis disposed at an angle to said first axis.

52. The method of claim 51, wherein said first axis is substantially normal to said second axis.

53. The method of claim 39, wherein said cathodes are formed on a same side of said substrate as said conductors, said cathodes and conductors being on a circuit side of said fuel cell layer.

54. The method of claim 39, further comprising sealing non-active portions of said substrate with said electrolyte.

55. The method of claim 39, further comprising:

forming a fuel inlet and an exhaust fluidly coupled to each said fuel flow channel;

forming a cathode air inlet and an excess cathode air outlet fluidly coupled to each said cathode air flow channel; and

disposing seals around said inlets, outlet and exhaust and around a perimeter of said fuel cell array.

56. The method of claim 55, wherein said seals comprise ceramic adhesive.

57. The method of claim 55, wherein said seals comprise an electrically conductive material.

58. The method of claim 39, wherein said fuel cell layers are coupled so as to form a parallel electrical circuit.

59. The method of claim 47, further comprising coupling a fuel manifold having a plurality of selectively opened inlet ports to said fuel flow plenums and disposing said fuel manifold within said fuel inlet plenum, and coupling an exhaust manifold having a plurality of selectively opened inlet ports to said fuel flow plenums and disposing said exhaust manifold within said exhaust plenum.

60. The system of claim 59, further comprising coupling a cathode air inlet manifold having a plurality of selectively opened inlet ports to said cathode air flow plenums and disposing said cathode air inlet manifold within said cathode air inlet plenum, and coupling an excess cathode air manifold having a plurality of selectively opened inlet ports to said cathode air flow plenums disposing said excess cathode air manifold within said excess cathode air plenum.

61. An electrochemical system, comprising:

means for supporting an array of fuel cells;

means defined in a first side of said support means for conveying cathode air across said array of fuel cells; and

means defined in a second side of said support means for conveying fuel across said array of fuel cells.

62. The system of claim 61, further comprising means for removing electricity from said array of fuel cells.

63. The system of claim 62, further comprising a plurality of said supporting means.

64. The system of claim 63, wherein said plurality of supporting means comprises means for delivering and removing fuel and cathode air to and from said system.

65. The system of claim 61, wherein said cathode air and said fuel flow in directions substantially normal to each other across cathodes and anodes of said fuel cells respectively.